Workshop Report: Monitoring Programme and Network Design for Surface Water Bodies

Nairobi, 7-9th December 2017

UN Environment GEMS/Water Capacity Development Centre

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SUMMARY

The UN Environment GEMS/Water programme hosted a workshop at the United Nations Office at Nairobi (UNON) in December 2017. The workshop was the first full training workshop delivered by the GEMS/Water CDC, with content designed to meet capacity needs which were identified during the preceding scoping exercise for the region.

This first training workshop addressed monitoring programme and network design for surface waters, and comprised lectures and group-work sessions over three days. The workshop was attended by 22 participants from 16 countries (Figure 1), focussing on Anglophone countries in sub-Saharan Africa. Plans to deliver a similar workshop for Francophone, Lusophone and Arabic speaking countries will progress as resources become available.

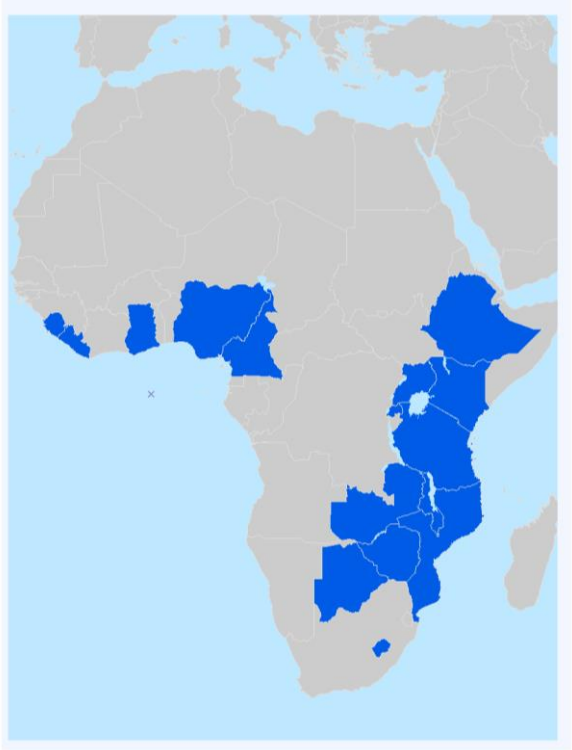

Figure 1: Workshop Participant Countries

Good design provides the necessary foundation for a water quality monitoring programme to meet its objectives and to provide data, and ensures the data are sufficient to support sound management decisions. This workshop provided participants with the necessary knowledge to help them complete the design process from setting objectives, through to programme review.

The workshop was attended by participants with a technical background, who are either actively involved in water quality monitoring and are looking at improving or extending their monitoring activities, or their country is in the early stages of monitoring programme design. Additionally, a representative from AMCOW (African Ministers' Council on Water) attended to further strengthen the relationship with GEMS/Water and to capacitate staff.

WORKSHOP PROGRAMME

The workshop was organised and delivered with contributions from each of the three GEMS/Water Centres: the Global Programme Coordination Unit (GPCU); the Data Centre (DC); with the majority of content being delivered by the Capacity Development Centre (CDC). Day One included a brief overview of GEMS/Water structure and mission, followed by introductions from all participants. The remainder of the day comprised presentations. Day 2 started with presentations in the morning, followed by group exercises after lunch. Day 3 followed a similar structure, but with the presentations on data management being delivered later than planned. Day 3 finished with a final group discussion and closing session. A summary of each session is provided below and the programme provided in Annex 2.

DAY 1

Monitoring for Information and Management

This session provided background information on water quality, describing what monitoring involves and why it is necessary. The role of water quality monitoring in water management was outlined and considerations for designing a successful monitoring programme were covered. The links between intended uses of the water and the necessity to choose monitoring methods accordingly were described. The benefits of monitoring programmes and the types of questions that can be answered by a well-designed programme were also covered.

In Summary:

- The quality of freshwater bodies is under threat from domestic, agricultural and industrial activities.
- Monitoring programmes are essential for:
  - Environmental protection by tracking and controlling the impacts of human activities
  - Selection and development of management options
  - Policy formulation
- Monitoring data need to be accessible in order to be useful for management and policy development
- The success of a monitoring programme is dependent on having clearly defined objectives allowing for a cost-effective monitoring programme designed in relation to the personnel and resources available.

Monitoring and Assessment Process Overview

The steps of developing a monitoring and assessment programme were described, including details of each step, and how these steps are organized into three phases: Design; Implementation; Assessment, Reporting and Management. The importance of each step and how the steps flow with each relying upon the preceding steps to design a sound and reliable monitoring programme was illustrated. The iterative nature of the design process, and how essential it is to define the monitoring programme objectives clearly from the outset, and to continuously refer to these through the design process, was covered.

Figure 2: Workshop Participants and GEMS/Water Team

Understanding Your Waterbody: Ecology and Hydrology

This session focussed on the importance of understanding natural influences on an aquatic system and how this leads to better monitoring programme design and interpretation of monitoring results. Geographical location and climate affect the water quality of rivers and lakes, and understanding how these can influence the ecological and hydrological nature of the aquatic system being monitored is critical for the design process. Without this understanding, vital elements of a programme may be omitted, or results may be misinterpreted. For example, it may be critical to know the seasonal fluctuations in nutrients and species of an aquatic system, or the variation in discharge of a river, to ensure the monitoring programme results are correctly interpreted.

Monitoring Sampling Location and Frequency

Sampling location and frequency are important considerations in monitoring network design because they affect how accurately the results obtained represent the water quality of the water body. This session looked at the different factors that need to be considered when identifying sampling locations and defining the frequency of sample collection, to provide a true representation of the water quality to meet the specific programme objectives. For example, a long-term surveillance programme of water quality at an abstraction point may require sample collection at a single location on a continuous basis. In contrast, a monitoring programme to provide information on the ecosystem health of surface waters at the national level, may require very many more locations, but monitored at a quarterly or seasonal frequency.

National Monitoring Programme Discussion

Each participant was offered the opportunity to summarise the state of surface water monitoring programmes in their own countries, and to discuss the limitations and points of interest. These are summarised below:

- Many countries do not have programmes which are fully able to describe surface water quality in their countries. There are some water bodies where the water quality is unknown or assumptions about water quality are made.
- The inclusion of community science as a means to expand water resource management is being investigated. With the community aspect serving as a "screening" mechanism, which can then identify locations where analysts can be deployed to investigate further.
- The need to develop water quality standards and target values for physico-chemical parameters was highlighted.
- Biological methods of water quality assessment are used in four countries out of the 16 countries represented.
- The need to focus on transboundary water quality was raised
- Certain countries employed consultants to design monitoring programmes.
- There is an analytical deficit, with some countries unable to analyse the necessary parameters.
- The storage and interpretation of data is a limitation in certain countries.
- Quality assurance is an issue especially when looking to use data derived from universities or research projects.
- Enforcement of controls on known water quality polluters is difficult in some countries because of vested interests of politicians.

DAY 2

Choosing What to Measure: Physical and Chemical Parameters

Water quality can be characterised by many different physical and chemical parameters. This session looked at various methods, and the constraints which must be considered when applying these methods. Physical parameters include temperature, pH, colour and transparency, whereas chemical methods include compounds such as nutrients, heavy metals and organic chemicals. It was illustrated that some parameters can influence the measured values of others, and that each parameter has its own requirements to be able to measure it accurately. The selection of the most appropriate parameters depends on the objectives of the monitoring programme.

Alternative Approaches to Monitoring

There are alternative approaches to collecting water quality data that can be considered in addition to traditional physical and chemical monitoring. Some of the main advantages are that they may be less expensive and provide a greater spatial coverage. This session looked at different approaches including: biological, continuous monitoring and sensors, remote sensing methods and also citizen and community monitoring approaches, and identified advantages and disadvantages that should be carefully considered. Also the reasons for considering alternative approaches to water quality monitoring were reviewed. These included: financial constraints, restricted access to advanced instrumentation, need for large spatial coverage, need for high frequency of data collection, a more applicable approach to address the programme objectives. An example would be using biological methods to assess ecosystem health.

Logistics and Planning

This presentation emphasised the importance of careful planning to ensure that time and resources are used efficiently, and that the objectives are achieved within the lifetime of the monitoring programme. Fieldwork comprises a significant portion of the total cost of many programmes, and thorough planning during the design phase is necessary to ensure the samples can be collected in a safe and efficient manner. During the implementation phase, activities, the importance of training of staff, use of field record sheets and sample handling were highlighted.

Figure 3: Workshop Participants Interacting During Sessions

Quality assurance and control

Errors can be introduced at all stages of sampling and analysis, and data are not credible if their quality cannot be assured. This session covered the importance of quality assurance plans and the associated procedures, and how these can help to minimise errors. The importance of applying quality assurance to field, laboratory and data storage operations and how this should be considered at the monitoring programme design phase, was highlighted. An overview of internal and external quality control procedures in a laboratory and some practical measures for ensuring the quality of monitoring results in the field and in the laboratory were also considered. Adequate resources need to be made available to implement the quality assurance plan.

Group Exercise - Site Selection

This exercise challenged participants to use their experience and the information provided during the workshop to suggest suitable monitoring locations and sample collection frequencies for one of four scenarios. Participants were divided into four groups of five or six with one of the participants acting as rapporteur for the group. The scenarios given to the groups were:

- Impact of an industrial discharge in a river
- Ambient water quality of an international river basin discharging to the ocean
- Impact of an accidental spill of a toxic liquid into a river feeding into a lake
- Early warning for a water intake point in the event of an accidental release of toxic compounds upstream

Group Exercise - Parameter Selection

The groups were then asked to suggest parameters which would best meet one of four monitoring programmes objectives. The scenario objectives were:

- Ambient water quality in a river
- Raw surface water that will be used for drinking without treatment
- Impact of untreated sewage discharge
- Ambient water quality in an international lake

DAY 3

Storage and Quality Control of Water Quality Monitoring Data

Accurate and quality-assured water quality monitoring data is the prerequisite for subsequent data analysis, interpretation and sound management of surface water resources. This session looked at the data component of design and implementation of a monitoring and assessment programme and how effective data management helps to:

- meet the data quality objectives and information requirements
- maximize the effective use and value of data and information products
- ensure appropriate use of data and information
- facilitate data sharing and re-use
- ensure sustainability and accessibility in the long term for re-use of data

Well planned and managed data storage is essential to ensure data integrity, to maximize use of data and to meet information requirements of a monitoring program. The need to plan and ensure quality control and assurance measures through the entire data life cycle was highlighted, and examples of good practice were provided.

Group Exercise - Monitoring Programme Design Simulation

Participants were divided into the same groups as on Day 2, and were each given the same task. Each group was asked to propose a water quality monitoring programme based on background information provided. The objective of the programme was to support the protection of the aquatic ecosystem in a fictitious river basin. The groups were supplied with maps of the river network and catchment which included elevation, land use and additional relevant information such as water use in the catchment and possible sources of pollution. Participants were also provided with limited historical water quality information and rainfall data for two locations in the catchment.

Participants were asked in their groups to apply the monitoring programme design process chart and prepare a presentation that was recommending the proposal to a group of stakeholders and the local water management authority. The suggested layout of the proposal included:

- Objectives of the monitoring programme
- Recommended monitoring approach and parameters
- Proposed sample sites and frequency of sampling
- Additional data and information needs
- Quality assurance for the monitoring programme
- Logistics and safety considerations
- Recommendations for data storage and assessment

Each group presented their proposal to the plenary, and an engaging feedback session involving numerous questions and clarifications from both participants and the GEMS/Water team followed.

Figure 4: Workshop Participants Involved in Group Work

WORKSHOP OUTCOMES

This workshop addressed some of the capacity needs of sub-Saharan Africa identified during the scoping phase of the GEMS/Water project plan. Twenty-two participants from 16 countries were trained in monitoring programme and network design for surface water bodies. Additionally, participants were provided with training materials in electronic form to run training initiatives in their own organisations.

Understanding the principles of good monitoring programme design is essential because it provides the foundation for many aspects of water quality management which future GEMS/Water training initiatives plan to build upon. These planned initiatives include workshops and delivery of training material focussing initially on QA/QC (quality assurance and quality control) procedures and also on data management.

The feedback from participants was encouraging (summarised in Annex 3) and reinforced the concept that the training provided is meeting training needs. Certain points were highlighted including that the workshop could have been longer, included practical work in the field. Additionally, many participants highlighted the need for training in many aspects of data management, which is a key issue for many countries. Delivery of workshops in the other languages of the Africa region will be addressed in coming workshops.

ANNEXES

Annex 1 – Participant List

GEMS/Water Capacity Development Centre training workshop:

Monitoring programme and network design for surface water bodies

7-9 December 2017

Room CR7 United Nations Complex, Gigiri, Nairobi, Kenya

Country	Participant	Organization	E-mail	Telephone
Botswana	Kubuya Mukokomani	Ministry of Minerals, Energy and Water Resources		
Cameroon	Fantong Wilson	Center for Hydrological Research		
Ethiopia	Yirgalem Esuneh Endalew	Ministry of Water, Irrigation and Electricity		
Ghana	Michael Akwei	Environmental Protection Agency		
Kenya	Fred Nyongesa	Water Resources Authority		
Kenya	Mbaruku A. Vyakweli	Nairobi City Water & Sewerage		
Kenya	Nahason Muguna	Nairobi City Water & Sewerage		
Kenya	Michael Onyango	Nairobi City Water & Sewerage		
Lesotho	Molefe Mokhatla	Ministry of Water		
Liberia	Morris Gono	National Public Health Institute		
Malawi	Kelvin Maluwa	Ministry of Agriculture Irrigation and Water Development		
Mozambique	Lily Nomboro	Ministry of Public Works, Housing and Water Res.		
Nigeria	Habu Jamilu	Federal Ministry of Water Resources		
Nigeria	Felix Ogundipe	Federal Ministry of Water Resources		
Nigeria	Peter Kunehepon	Federal Ministry of Water Resources		
Nigeria	Emmanuel Uguru	AMCOW		
Rwanda	Karuranga Dismas	Rwanda Water and Forestry Authority		
Sierra Leone	Ishmail Kamara	Ministry of Water Resources		
Tanzania	Mteki Heri Chisute	Ministry of Water & Irrigation		
Uganda	Lillian Idrakua	Ministry of Water and Environment		
Zambia	Emmanuel Sakevo	Water Resources Management Authority		
Zimbabwe	Tracey Kudzanai Mubambi	Environmental Management Agency		
Facilitators				
Germany	Philipp Saile	Federal Institute of Hydrology	saile@bafg.de	
Germany	Claudia Faerber	Federal Institute of Hydrology	faerber@bafg.de	
Ireland	Debbie Chapman	University College Cork	d.chapman@ucc.ie	
Ireland	Stuart Warner	University College Cork	s.warner@ucc.ie	

Annex 2 – Workshop Programme

GEMS/Water Capacity Development Centre training workshop:

Monitoring programme and network design for surface water bodies

7-9 December 2017

Room CR7 United Nations Complex, Gigiri, Nairobi, Kenya

Thursday 07 Dec		**Facilitator**
08.45 – 09.15 09.15 – 09.30 09.30 -10.00 10.00 – 10.30	Registration Welcome remarks. UN Environment Brief overview of GEMS/Water Introduction of participants and objectives of the workshop	 Hartwig Kremer Deborah Chapman
10.30 – 11.00	Refreshments	
11.00 – 12.00	Monitoring for information and management	Deborah Chapman
12.00 – 13.00	Monitoring and assessment process overview	Stuart Warner
13.00 – 14.00	Lunch	
14.00 – 15.00	Understanding your waterbody: ecology and hydrology	Deborah Chapman
15.00 - 15.30	Monitoring sampling location and frequency	Stuart Warner
15.30 – 16.00	Refreshments	
16.00 – 17.00	National monitoring programme discussions	Participants
17.00 – 17.30	Discussion and group feedback	All

Friday 08 Dec		**Facilitator**
09.00 – 10.00	Choosing what to measure: physical and chemical parameters	Stuart Warner
10.00 – 11.00	Alternative approaches to monitoring	Deborah Chapman
11.00 – 11.30	Refreshments	
11.30 – 12.15	Logistics and planning	Stuart Warner
12.15 – 13.00	Quality assurance and control	Deborah Chapman
13.00 – 14.00	Lunch	
14.00 – 15.30	Site selection group exercise	Participant groups, D. Chapman, S. Warner, C. Faerber, P. Saile
15.30 – 16.00	Refreshments	
16.00 – 17.00	Parameter selection group exercise	Participant groups, D. Chapman, S. Warner, C. Faerber, P. Saile
17.00 – 17.30	Discussion and group feedback	All

Saturday 09 Dec		**Facilitator**
09.00 – 10.00	Data management planning	P. Saile
10.00 – 11.00	Data quality assurance	P. Saile
11.00 – 11.30	Refreshments	
11.30 – 12.00	Introduction of group simulation exercise	Deborah Chapman
12.00 – 13.00	Group work on monitoring programme design simulation	Participant groups, D. Chapman, S. Warner, C. Faerber, P. Saile
13.00 – 14.00	Lunch	
14.00 – 15.30	Group work on monitoring programme design simulation continued	Participant groups, D. Chapman, S. Warner, C. Faerber, P. Saile
15.30- 16.00	Refreshments	
16.00 – 17.00	Group presentation and discussion	Participant groups
17.00 – 17.30	Feedback session and close of workshop	All

Annex 3 – Workshop Feedback Summary

No.	Question	Disagree strongly	% of results	Disagree mildly	% of results	Don't know/No Comment	% of results	Agree mildly	% of results	Agree strongly	% of results
1	The objectives of the workshop were clear	0	**0%**	0	**0%**	0	**0%**	1	**6%**	15	**94%**
2	The content of the workshop was relevant to you	0	**0%**	0	**0%**	0	**0%**	3	**18%**	13	**82%**
3	The workshop introduced you to new topics and ideas	0	**0%**	0	**0%**	2	**13%**	6	**38%**	8	**50%**
4	Presentations were generally clear and well presented	0	**0%**	0	**0%**	0	**0%**	2	**13%**	14	**88%**
5	You will use what you have learned in the workshop in your current role	0	**0%**	0	**0%**	0	**0%**	2	**13%**	14	**88%**
6	The workshop was enjoyable	0	**0%**	0	**0%**	0	**0%**	2	**13%**	14	**88%**

A: Did you find any section or topic of the workshop particularly useful?

Design of monitoring programme	Quality assurance/Quality control	Data analysis/storage/ interpretation	Alternative approaches to monitoring/ sampling locations	Biological monitoring
5*	4	3	3	1

*numbers denote the number of participants agreeing with statement

B: Did you find any section of the workshop of little interest or use to you in your current role?

All topics relevant

C: Are there any topics that were not included that you think should be? It so, suggest topics

Data management (processing/statistical data analysis/methods/parameters/ dissemination)	Overview of water quality more broadly (e.g specific to regional/country/global)	Water quality modelling	Economic aspect of water quality/monitoring/assessment	Bio-monitoring using diatoms	GIS application
6	1	1	1	1	1

D: How could the structure or content of the workshop be improved?

Field work should be included	More details in the presentations /more on case studies	Data management / statistical analysis	Ideas for community participation of capacity development	Ideas on how to design a quality monitoring programme	Workshop too short
5	2	2	1	1	1

E: Any other comments/suggestions?

Very positive overall	Visitation to specific sites/Fieldwork	Practical training / equipment / parameters / calibration	More on data management	Workshop too short	Lunch should be included
16	2	1	1	1	1